DECLARATION

I, Toshiharu INOUE of Yakohama, Japan, the translator of the Japanese Application Ser. No. 0003084, do hereby certify to the best of my knowledge and belief that the herewith enclosed is a true translation into English of the corresponding copy of the document which has been filed with the Japanese Patent Office on January 12, 2001, with respect to an application of Letters Patent.

Signed, this 20th day of June 2002

Toshiharu INOUE

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METHOD AND APPARATUS FOR INITIALIZING PHASE-CHANGE OPTICAL RECORDING MEDIUM, AND PHASE-CHANGE OPTICAL RECORDING MEDIUM

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[Title of the Invention]

METHOD AND APPARATUS FOR INITIALIZING PHASE-CHANGE OPTICAL RECORDING MEDIUM, AND PHASE-CHANGE OPTICAL RECORDING MEDIUM

[What is claimed is:]

[Claim 1]

A method for initializing a phase-change optical recording medium by irradiating said recording medium with a scanning beam spot emitted from a high power semiconductor laser device, said recording medium being capable of carrying out optically read/write/erase operations of information data onto said recording medium,

wherein an energy density input by said beam spot during one beam scan over an entire medium area is equal to, or less than, 1000 J/m^2.

[Claim 2]

The method according to claim 1,

wherein an energy density input by said beam spot during one beam scan over an entire medium area is equal to, or larger than, 600 J/m^2.

[Claim 3]

The method according to anyone of claims 1 and 2,

wherein a scanning velocity of said beam spot is in a range of 3.5 to 6.5 m/sec.

[Claim 4]

The method according to anyone of claims 1 through 3,

wherein an intensity of an emission from said semiconductor laser device is equal to, or greater than 330 mW.

[Claim 5]

The method according to anyone of claims 1 through 4, wherein a width of overlapped portion, which is formed as an overlap of irradiated portions, between two neighboring irradiation tracks on said recording medium during two consecutive rotations of said recording medium in initializing steps, is equal to, or less than, 0.5 Wr, where Wr is a width at half maximum of a spatial laser power distribution in a direction perpendicular to beam scanning direction.

[Claim 6]

An apparatus configured to perform at least an initialization operation onto a phase-change optical recording medium by irradiating said recording medium with a scanning beam spot emitted from a high power semiconductor laser device, said initialization operation including at least the steps as claimed in anyone of claims 1 through 5.

[Claim 7]

A rewritable phase-change optical recording medium, said recording medium being initialized at least by the steps as claimed anyone of claims 1 through 5.

[Detailed Description of the Invention]

[0001]

[Technical field of the Invention]

This patent specification relates to an optical information recording medium in general and, more particularly, to a

phase-change type optical recording medium such as, for example, CD-RW, DVD-RAM, DVD-PW, DVD+ RW and PD, and a method and apparatus for use in initializing such recording media.

[0002]

[Background Art]

As to the initialization process of an optical information recording medium including phase-change recording materials, several improvements are disclosed in apparatuses and methods for the media initialization.

For example, Japanese Laid-Open Patent Application No. 8-77614 discloses an apparatus devised with a tandem type optical system to implement a uniform, high speed initialization of the phase change optical recording medium. Also described in the disclosure are specified shapes of laser beams to be irradiated onto the recording medium for the initialization.

However, since no description is given on intensities or irradiation energy of the laser beams, recording media with satisfactory recorded signal quality are not considered feasible by that disclosure alone. In addition, there found are neither the description on the multiple speed recording nor recording characteristics at linear velocity of 4.8 m/sec or larger.

[0003]

Japanese Laid-Open Patent Application No. 9-73666 discloses an optical information recording medium, and the method and apparatus for forming the medium, in which optically readable marks are provided outside data recording regions on the medium for the media ID information to be stored for the

optical recording medium.

[0004]

Another optical recording medium, and the method and apparatus for initializing the medium are disclosed in Japanese Laid-Open Patent Application No. 9-212918, which is characterized by melting at least a portion of the recording layer during the initialization. As to the method and apparatus, the shape of laser beams on the medium during the initialization steps is specified such that the longer axis (i.e., major axis) of either approximated ellipsoidal or rectangular shape thereof be aligned perpendicular to recording tracks, to thereby be able to improve the characteristics of recorded signals. In addition, the layer construction of the recording medium is specified as well in that disclosure.

Although there indicated in the above disclosure is that the improvement in recording characteristics is achieved by melting at least a portion of the recording layer during the initialization, as noted earlier, no description is found on irradiation energy of the laser beams, and the irradiation energy, in turn, is considered to have a considerable effect on the melting process.

As a result, the improvement in recording characteristics, are considered not necessary feasible by this disclosure alone. In addition, there found is again neither the description on the multi-speed recording nor recording characteristics at linear velocity of 4.8 m/sec or larger.

[0005]

Japanese Laid-Open Patent Application No. 10-241211 describes on improved initialized characteristics which are

achieved by carrying out a layer processing step prior to the initialization during a recording media fabrication. In this disclosure, however, the initialization is made twice in fact, this is considered to result in the decrease in productivity. In addition, no description is found again on the multi-speed recording and recording characteristics at linear velocity of 4.8 m/sec or larger.

[0006]

A further optical information recording medium, and the method and apparatus for initializing the medium are disclosed in Japanese Laid-Open Patent Application No. 10-289447, in which the axis of beam shape of a laser on a medium under irradiation be aligned in a manner other than parallel to recording tracks to result defocused beams.

According to the disclosure with the above alignment, it is effected to decrease the unevenness in reflectivity resulted from the initialization, also in the initialization effect in the layer, which may be caused by the overlap of repetitive exposures of the beam irradiation, to thereby prevent for the beams be off the track. However, no description is found on irradiation energy of the laser beams, and neither described is again the description on the multiple speed recording and recording characteristics at linear velocity of 4.8 m/sec or larger.

[0007]

[Problems to be solved by the Invention]

For a phase-change type optical recording medium typically exemplified by, for example, CD-RW, DVD-RAM, DVD-PW, DVD+

RW and PD, a recording layer included therein is in the amorphous state immediately after the layer formation, as described earlier. The recoding layer, therefore, has to be subjected to so called initialization process, in which the layer is crystallized by laser annealing process steps to thereby become crystallized to yield a high enough reflectivity suitable for data recording.

During the initialization process steps, light beams from a high intensity semiconductor laser, gas laser, and other similar devices, are focused to be scan irradiated onto the surface of the recording layer, thus to heat the recording layer to be brought to be either in, or close to, its melted state, and subsequently to be in, or close to, its crystalline state. It is known the process of the initialization has in general a considerable effect on the resultant signal recording characteristics such as overwrite capability, in particular, of optical recording media.

[0008]

Since the speed of media recording is ever increasing recently, it is highly desirable for information recording media be devised to have satisfactory recording capabilities at various velocities (i.e., multi-speed recording) exemplified by, for example, CAV (constant angular velocity) recording and excellent signals characteristics after recorded, as well.

[0009]

Based on the abovementioned current status of the characteristics of the recording medium, several improvements are made in the present disclosure, in which a method and an apparatus are provided for use in initializing the optical

recording medium, which has multi-speed recording capabilities at the velocity of 4.8 m/sec or larger, to attain satisfactory overwrite characteristics up to its largest warranted linear recording velocity.

[0010]

[Means for Solving the Problems]

These above noted objects are attained with the means, which follows.

First, according to claim 1, a method disclosed herein for initializing a phase-change optical recording medium by irradiating the recording medium with a scanning beam spot emitted from a high power semiconductor laser device, with the recording medium being capable of carrying out optically read/write/erase operations of information data onto the recording medium, is characterized primarily by an energy density input by the beam spot during one beam scan over an entire medium area being equal to, or less than, 1000 J/m^2.

[0011]

Second, according to claim 2, the method for initializing the phase-change optical recording medium described above in claim 1 is further characterized by the an energy density input by the beam spot during one beam scan over an entire medium area being equal to, or larger than, 600 J/m^2.

[0012]

Third, according to claim 3, the method for initializing the phase-change optical recording medium described above in claim 1 or 2 is further characterized by the scanning speed of beam

spot ranging between 3.5 m/sec and 6.5 m/sec.

[0013]

Fourth, according to claim 4, the method for initializing the phase-change optical recording medium described above in any one of claims 1 through 3 is further characterized by the intensity of the emission from the semiconductor laser device is equal to, or greater than 330 mW.

[0014]

Fifth, according to claim 5, the method for initializing the phase-change optical recording medium described above in any one of claims 1 through 4 is further characterized by the width of overlapped portion, which is formed as an overlap of irradiated portions, between two neighboring irradiation tracks on the recording medium during two consecutive rotations of the recording medium in initializing steps, is equal to, or less than, 0.5 Wr, where Wr is the width at half maximum of a spatial laser power distribution in the direction perpendicular to beam scanning direction.

[0015]

Sixth, according to claim 6, an apparatus is disclosed herein for initializing a phase-change optical recording medium which suitable adapts the methods described above in any one of claims 1 through 5.

[0016]

Seventh, according to claim 6, a phase-change optical recording medium is disclosed, which is suitably initialized by the method for initialization described above in any one of claims 1 through 5.

[0017]

[DESCRIPTION OF THE PREFERRED EMBODIMENTS]

Preferred embodiments will be detailed herein below with respect to the methods for initializing a phase-change optical recording medium, and an apparatus for the initialization adapted the above methods.

FIG. 1 is a schematic diagram illustrating an initialization apparatus according to one embodiment disclosed herein.

Referring to FIG. 1, the initialization apparatus includes at least a semiconductor laser device 1 as a light source, a collimator lens 2 for collimating laser beams, a beam splitter 3 for dividing reflected beams, an objective lens 4, another collimator lens 5, and an auto-focusing (AF) unit 6 including at least a detector and an actuator.

[0018]

There utilized as the laser source are a semiconductor laser, a gas laser, and other similar laser devices. Of these devices, a high power semiconductor laser device is preferred for its smallness in size and low in costs.

The output power thereof is in general in the range between 400 to 1000 mW. Among the beam shapes thereof which suitably be selected for use in initialization, either ellipsoidal or rectangular shape in the near field pattern may preferably be utilized with the lengths of the major and minor axes ranging from 10 to 500 μm and from 0.5 to 10 μm, respectively.

When the laser beams are aligned such that the longer axis

thereof be aligned at least close to perpendicular to recording tracks, there result in the increase in the disc area (or medium area) covered by the laser beams per disc rotation. As a result, the initialization efficiency can be increased, thereby facilitating to reduce initialization time with this alignment of the laser beams.

The output beams of the semiconductor laser device 1 as the light source is collimated through the collimator lens 2, and then focused onto at least in the vicinity of the recording layer included in the medium by the objective lens 4 to be irradiated with radiation energy, whereby data recording is achieved.

Portions of the laser beams are reflected from the disc surface, lead to the beam splitter 3 though the objective lens 4, and directed to the AF unit 6 after being divided by the beam splitter 3, thereby being utilized for establishing proper focus through the movement of the objective lens 4.

The method for establishing and maintaining the focus is carried out by previously known method such as, for example, the knife-edge and astigmatic methods. The unit shown herein above in FIG. 1 is hereinafter referred to as 'initialization head'.

[0019]

The method for initializing recording media disclosed herein is implemented by scanning the initialization head over the area of recording medium. The detailed conditions of the initialization may be adjusted arbitrarily, and an apparatus therefor is illustrated in FIG. 2 in the case of disc-shaped recording medium.

[0020]

Referring to FIG. 2, the initialization apparatus according to one embodiment disclosed herein includes at least a spindle mechanism 11 for rotating optical recording medium 9, and initialization head 10 provided with at least with an actuator for displacing the initialization head.

The laser beam scanning is carried out with the thus constructed apparatus, by rotating the optical recording medium 9 by the spindle mechanism 11 and simultaneously displacing the initialization head 10 in the radial direction of the medium. The laser beams are therefore scanned spirally over the area of the recording medium to achieve the initialization.

Since the spindle mechanism 11 and initialization head 10 are constructed to be operable in the interlocked manner, the disc rotation and the movement for displacing the initialization head 10 in the radial direction is also controlled in this manner.

In addition, these rotating and displacing movements are controlled with the above construction such that the speed, at the location of beam irradiation, of the initialization head 10 relative to the rotating medium portion is maintained to be constant, V. As a result, a constant scanning speed is achieved and maintained during medium initialization with laser beam irradiation.

[0021]

The initialization head 10 may be displaced either from the outer edge to inward of the disc or the other way around during the beam scanning. The initialization is carried out at least over the data recording area on the disc, and may also be made the area there beyond.

In order for the recording layer be adequately initialized throughout the disc area, a displacement step, d, (or the amount of displacement in the direction perpendicular to the disc tracks) of the initialization head 10, and the width at half maximum, Wr, of the spatial laser power distribution in the direction perpendicular to the disc tracks, preferably satisfy the relation, $d < Wr$. That is, the displacement step has to be smaller than the width at half maximum of the spatial laser power distribution of the laser device.

[0022]

In addition, the overlap of irradiated portions has to be further considered. Since such overlapped area portions result in the area irradiated substantially more than once, spatial fluctuation may be created in the initialization effect over the disc area. This spatial fluctuation further results in microscopic reflectivity fluctuation especially at the overlapped portions.

In order to decrease the reflectivity fluctuation, it is preferable for the width of the overlapped portion, $Wr - d$, and the width at half maximum, Wr, of the spatial laser power distribution satisfy the relation, $Wr - d < 0.5\ Wr$.

[0023]

The optical recording medium described herein below in reference to FIG. 3.

The phase-change optical recording medium in the present disclosure includes a transparent supporting substrate 21, and the following layers formed contiguously on the supporting substrate in order as follows: A first dielectric layer 22, a

recording layer 23, a second dielectric layer 24, a reflective layer 25, and a protective layer 26.

Furthermore, a printed layer 27 and a hard coat layer 28 may additionally be formed on the overcoat layer 26 and on the lowermost face of the transparent substrate, respectively.

[0024]

The transparent substrate 21 is formed of materials preferably enough transparent to light in the wavelength range for use in recording and readout operations of the recording medium.

Suitable materials for forming the transparent substrate 21 include glass, ceramics and resinous materials. Of these materials, resins are preferably employed for its satisfactory transparency and moldability.

Specific examples of the resins include polycarbonate resins, acrylic resins, epoxy resins, polystyrene resins, acrylonitrile-styrene copolymeric resins, polyethylene resins, polypropylene resins, silicone resins, fluororesins, acrylonitrile-butadiene-styrene (ABS) resins and urethane resins. Among these resins, polycarbonate resins and acrylic resins are preferably used for their excellent molding ability, optical properties and relatively low costs. In addition, guiding tracks (grooves) may be provided on the transparent substrate.

[0025]

The first and second dielectric layers, 22 and 24, are formed primarily consisting of dielectric materials for their suitable thermal and optical properties.

Examples of suitable dielectric materials for forming the

dielectric layers include oxides such as SiO_2, SiO, ZnO, SnO_2, In_2O_3, MgO and ZrO_2; nitrides such as Si_3N_4, AlN, TiN, BN and ZrN; sulfides such as ZnS, In_2S_3 and TaS_4; carbides such as SiC, TaC, B_4C, WC, TiC and ZrC; diamond-like carbon, and these materials may be used individually and in combination thereof.

[0026]

Respective dielectric layers can be formed by, for example, vacuum evaporation, sputtering, ion plating, CVD, or other similar methods. Of these, the sputtering method is preferably utilized for its excellent productivity and properties of resultant layers.

The materials and thickness of the first and second dielectric layers may be determined independent one another after considering optical and thermal properties. The thickness generally ranges between 10 to 5000 nm.

[0027]

The recording layer 23 is formed consisting of phase-change recording materials. Examples of the recording materials include alloys such as GeTe, GeTeSe, GeTeS, GeSeSb, GeAsSe, InTe, SeTe, SeAs, Ge-Te-(Sn, Au, Pd), GeTeSeSb, GeTeSb, AgInSbTe, GeInSbTe and GeAgInSbTe. The composition of the alloys may properly be adjusted to attain optimum recording sensitivity depending on the linear recording velocity.

In addition, it is effective for the recording layer to incorporate other elements or impurities to further improve media characteristics. For example, these additives are preferably selected from the group consisting of B, N, C, O, Si, P, S, Se, Al, Ti, Zr, V, Mn, Fe, Co, Ni, Cr, Cu, Zn, Sn, Pd, Pt and Au.

and as disclosed in Japanese Laid-Open Patent Application No. 4-1488, and another group consisting of S, Se, Al, Ti, V, Mn, Fe, Co, Ni, Cu, Zn, Ga, Sn, Pd, Pt and Au.

[0028]

It may be added the boundary between the stable (crystalline) phase and metastable (amorphous) phase is formed quite clearly for the AgInSbTe recording materials in particular, which is advantageous for the mark-edge recording. This effect is enhanced by adding a small amount of N as an impurity, to yield wider margins of linear recording velocity.

[0029]

The recording layer 23 can be formed by, for example, vacuum evaporation, sputtering, ion plating, CVD, or other similar methods. Of these, the sputtering method is preferably utilized for its excellent productivity and low costs.

[0030]

The reflective layer 25 is formed to reflect light beams during recording and read out steps, also to serve dissipate the heat generated during recording steps.

Examples of suitable materials for forming the reflective layer 25 include metals such as Ag, Au and Al, and alloys thereof added with at least one impurity selected from the group consisting of Ti, Is, Cr, Ta, Cu, Pd and C. Of these, the alloys including Al as the major component are preferably used.

The composition and thickness of the reflective layer may be determined independent one another to be suitably optimized after considering optical and thermal properties.

[0031]

The protective layer 26 is preferably formed, primarily consisting of light curing or electron beam hardening resinous materials. Of these, photo-curing resins are preferably utilized for relative ease in disposing and hardening the material during the layer formation.

As the photo-curing resin, ultraviolet curing resins are generally used, which may be disposed by spin coating or dipping method.

[0032]

Furthermore, a printed layer 27 may be formed on the protective layer, when relevant, to thereby serve as a label, and a hard coat layer 28 may additionally be formed on the mirror face of the substrate, to thereby increase surface strength against scratches. Examples of the material for use in the printed layer 27 may be selected from the group of conventional photo-curing inks which are printed generally by the screen printing method.

The materials and the method for forming the hard cost layer may be selected from ones similar to those for the protective layer 26. In addition, a couple of recording discs may be adhered with two overcoat layers back to back so as to form a single recording disc.

[0033]

The apparatus and method for carrying out the media initialization process disclosed herein are characterized by the energy density to be used therefor, as will be detailed herein below.

The output laser power and scanning speed for the media initialization have to be determined by an energy density input

into a recording medium during one scanning period.

[0034]

The energy density E is expressed by the relation,

$$E = P \cdot V / (S \cdot Wt) = P / (Wr \cdot V) \qquad \text{(Eq. 1)},$$

where P is output laser power, V scanning speed, S the area on the medium under irradiation, and Wt and Wr the width of the laser beam in the direction along, and perpendicular to, the scanning direction, respectively.

The energy density value expresses the amount of energy input into the unit area of the recording medium during one scanning period, and this value is therefore directly related to the effect generated on the recording layer by the initialization process.

As the energy density E increases, the amount of heat generated in the medium increases, thereby causing the increase in temperature in the recording layer. As a result, the recording layer can be brought into the stable crystalline state.

However, the energy density E of unduly high causes the following difficulties: When amorphous marks are formed on the thus formed crystalline recording layer through further beam irradiation, edge portions of the marks become more highly crystallized by the heat from the above-mentioned irradiation. As a result, when lands are subsequently overwritten on top of the recorded marks, these marks become so stabilized that they can not be completely erased, to thereby result in the deterioration in jitters during the first overwrite step.

The upper limit of the energy density E max, which assures satisfactory first overwrite characteristics, is thus obtained as E

max = 1000 J/m². Accordingly, it is necessary for the recording medium disclosed herein be initialized at least under the condition of the energy densities of E $\leq$ E max.

In this context, it is noted E values higher than E max have been generally adopted previously for media initialization. For example, the E values used in practice are in the range of 1100 to 1400 J/m² in the case of CD-RW discs having linear recording velocities of 1.2 to 4.8 m/sec. The E values for the initialization as high as the present example are considered to cause the above noted deterioration in jitters during the first overwrite step, especially at high linear velocities.

[0035]

For unduly low E values, in contrast, the amount of heat input into the recording layer is insufficient to achieve satisfactory crystallization results. Many portions therefore remain as non-crystallized and the media reflectivity also remains low.

When the thus formed (or prematurely initialized) medium is subjected to repetitive overwrite steps, the crystallization of the premature media portions are accelerated with the increase in the number of overwrite cycles, whereby changes in reflectivity results which are considerably larger than those with its initial value.

As a result, recorded signal qualities following the large number of overwrite cycles are also changed considerably from initial qualities, thereby resulting in jitter value deterioration after a large number of recording cycles, which is disadvantageous in use for practical recording media.

The lower limit of the energy density, E min, which assures to alleviate the jitters deterioration after the large number of overwrite cycles, is thus obtained as E min = 600 J/m^2.

Accordingly, it is preferable for the recording medium disclosed herein be initialized at least under the condition of the energy densities of E min $\leq$ E.

[0036]

The scanning speed, V, has a large effects on unevenness in reflectivity resulted from the initialization. For unduly high V values, portions of the recording medium remain to be non-crystallized (or prematurely crystallized) more often, which is caused at least partially by the failure in tracking movements by focus servo unit, which is, in turn, caused by the high V values. This spatial difference in crystallization has effects on the reflectivity, as indicated earlier, thereby resulting in spatial fluctuation in reflectivity and further causing possible failure in tracking.

For unduly low V values, in contrast, the beam irradiation time is prolonged and the recording and dielectric layers in the recording medium tend to be affected more often by heat damages. As a result, the deterioration in recording characteristics such as jitters, in particular, is caused after a large number of overwrite cycles.

Accordingly, it is preferable for the recording medium disclosed herein be initialized at least under the conditions with respect to the scanning speed V, specified as V min $\leq$ V $\leq$ V max, with V min = 3.5 m/sec and V max = 6.5 m/sec.

[0037]

[EXAMPLE]

The following example is provided further to illustrate preferred embodiments of the present invention. This is intended to be illustrative but not to be limiting to the materials, apparatuses or methods described herein.

A CD-RW recording medium was formed, as illustrated in FIG. 3, including at least a polycarbonate substrate provided with guide tracks of a continuous spiral groove for use in CD-RW discs, and constituent layers formed thereon in order as follows: A first dielectric layer, a recording layer, a second dielectric layer, a reflective layer, and a protective layer.

The first and second dielectric layers were deposited by PF sputtering using sputtering targets of $SiO_2 \cdot ZnS$ composition, and the recording layer was formed by DC sputtering using a sputtering target of AgInSbTe alloy composition. In addition, the reflective layer was formed by DC sputtering using a sputtering target of Al and Ti, as major components.

The first dielectric layer had a thickness of 80 nm, recording layer 20 nm, second dielectric layer 30 nm, the reflective layer, and protective layer 150 nm, respectively.

By spin coating a layer of UV curing resinous material on the recording medium, and hardening by UV irradiation, the formation of recording medium was completed.

This recording medium was subsequently subjected to initialization process steps using an initialization apparatus equipped with an initialization head operated under the following conditions:

$\lambda = 810$ nm,

$Rr = 100$ μm,

$Rt = 1.0$ μm, and

$d = 60$ μm.

[0038]

The conditions of medium initialization were shown in Table 1. There found for the recording medium is auto-focusing was not feasible with an initialization power of less than 330 mW, whereby the media initialization was unfeasible.

Also found is that the CD-RW recording media formed as above have satisfactory media characteristics as high speed CD-RW discs capable of carrying out read/ write/ erase operations according to Orange Book specification (Part III, Vol. 2) at the linear recording velocities ranging from CD4× to CD10× speed.

[0039]

Subsequently, data recording steps were carried out onto the initialized recording media according to the Orange Book specification, in which Spin Tester DDU1000 from PulseTech Co. was used as a CD-RW measurement apparatus equipped with an optical pickup unit under the following conditions:

$\lambda = 795$ nm,

NA = 0.5,

Linear recording velocity = 12.0 m/sec (CD10×), and

Coding : EFM.

In addition, the beam power for the recording was used ranging from 19 mW to 21 mW according again to the Orange Book specification, and the results on first direct overwrite (DOW 1) and direct overwrite after 1000 cycles (DOW1000) were

primarily obtained. The recorded signals were then readout with the Spin Tester DDU1000 and, 3T land jitters were measured. The results obtained on the readout signals are shown in Table 1.

[0040]

Table 1

Initialization conditions			Characteristics of recorded signals			
V (m/sec)	P (mW)	E (J/m^2)	Initial 3T LJ	DOW 1 3T LJ	DOW 1000 3T LJ	ΔR_{gh}
3	330	1100	20.2	37.4	35.8	0.04
3	385	1283	19.9	42.8	38.5	0.04
3	440	1467	20.1	49.5	42.2	0.03
3	495	1650	21.2	54.9	44.5	0.04
3	550	1833	21.5	61.8	46.5	0.04
4	330	825	21.3	25.3	26.0	0.06
4	385	963	20.9	28.2	27.3	0.06
4	440	1100	20.0	35.8	30.0	0.05
4	495	1238	18.8	46.5	32.2	0.05
4	550	1375	18.5	55.3	34.4	0.04
5	330	660	22.2	24.9	27.7	0.08

5	385	770	21.5	23.8	28.3	0.07
5	440	880	22.2	25.5	26.6	0.05
5	495	990	23.1	28.1	27.2	0.05
5	550	1100	22.2	36.7	28.9	0.04
6	330	550	27.2	27.8	24.3	0.12
6	385	642	24.1	26.2	25.5	0.10
6	440	733	24.0	24.7	27.3	0.08
6	495	825	23.1	23.9	27.5	0.07
6	550	917	23.2	25.1	28.8	0.07
7	330	471	30.2	32.2	27.2	0.45
7	385	550	27.1	28.1	27.5	0.43
7	440	629	25.2	25.9	28.2	0.32
7	495	707	22.1	24.8	27.8	0.30
7	550	786	22.2	23.6	28.3	0.22

[0041]

The 3T land jitters were measured with varying initialization power P and scanning speed of the initialization head V, and the results from the measurements are shown also in FIG. 4. It is indicated from the results that the jitters increase with the decrease in P and V. At the same time, the magnitude of energy density E is plotted as a function of P and V in FIG. 5.

When these values shown in FIGS. 4 and 5 are compared, it

is found DOW 1 jitters tend to increase with decreasing energy density E. Also found is the following range of the E value, for which jitters exceed 35 nsec that is specified as a standardized jitter value in the Orange Book;

$$E > 1000 \text{ J/m}^2$$

[0042]

Similarly, 3T land jitters after 1000 cycles of direct overwrite (DOW1000) were measured with varying initialization power P and scanning speed of the initialization head V, and the results from the measurements are shown also in FIG. 6.

When the values shown in FIGS. 6 are compared with those in FIG. 5, it is found the DOW 1000 3T land jitters tend to increase with decreasing energy density E. Also found is the following range of the E value, for which jitters exceed again 35 nsec that is specified in the Orange Book;

[0043]

$$E < 600 \text{ J/m}^2$$

Considering these results, it is indicated satisfactory values for both DOW1 and DOW1000 3T land jitters are obtained for E values in the range of

$$600 \text{ J/m}^2 \leq E \leq 1000 \text{ J/m}^2,$$

whereby CD-RW discs can be prepared with excellent overwrite characteristics.

Furthermore, as shown also in Table 1, DOW1000 3T land jitters remain relatively high for the scanning speed of 3 m/sec regardless P values, and the overwrite characteristics are found to be able be improved by satisfying the relation, $V \geq 3.5$ m/sec.

[0044]

The change in disc reflectivity, ΔRgh, is also obtained at the time immediately after the initialization and prior to recording as follows. Namely, reflectivity values of the disc reflectivity, Rgh, were measured over the disc area prior to recording, to thereby yield several reflectivity values such as Rmax, Rmin and Ravg for its maximum, minimum, and average, respectively.

[0045]

The change in disc reflectivity, ΔRgh, is then calculated by the equation,

$$\Delta Rgh = (Rmax - Rmin)/Ravg \qquad \text{(Eq. 2)} .$$

Therefore, as the fluctuation in disc reflectivity over the disc area increases, the change in disc reflectivity or reflectivity fluctuation, ΔRgh, increases. The ΔRgh values were measured with varying initialization power P and scanning speed of the initialization head V, and the results from the measurements are shown in FIG. 7.

Since the reflectivity fluctuation ΔRgh exceeding 0.1 increases tracking error signals, failure in precise tracking such as off-tracking may be caused. This difficulty is alleviated by satisfying the relation with the scanning speed V, $V \geq 3.5$ m/sec, thereby decreasing the fluctuation.

[0046]

As a result, the range of suitable values, P and V, corresponding to the above noted results is shown with as the shaded area in FIG. 8.

[0047]

[Advantages of the Invention]

According to claim 1 in the present disclosure, the method for initializing a phase-change optical information recording medium to have sufficiently low jitters after the initial overwrite step can be achieved, since the energy density input to the recording medium by the beam spot during one beam scan over an entire medium area is controlled to be equal to, or less than, 1000 J/m^2, thereby reducing the energy input and also crystallization energy.

[0048]

According to claim 2, the method for initializing a phase-change optical information recording medium to have excellent characteristics with reduced signal fluctuation during overwrite steps can be achieved, since the energy density input to the recording medium by the beam spot during one beam scan over an entire medium area is controlled to be equal to, or larger than, 600 J/m^2, to thereby be able to provide a sufficient amount of heat to the recording layer and to reduce the spatial fluctuation in the degree of crystallization.

[0049]

According to claim 3, the method for initializing a phase-change optical information recording medium to have excellent overwrite characteristics can be achieved, since the optimum range of scanning speed during initialization steps is specified, to thereby be able to reduce undue formation of amorphous regions and to suppress thermal damage of the recording layer.

[0050]

According to claim 4, the method for initializing a phase-change optical information recording medium to suffice to maintain precise laser beam focusing during initialization steps can be achieved, since the intensity of emission from a semiconductor laser device is specified to be equal to, or greater than 330 mW, to thereby be able to acquire sufficiently large reflectivity.

[0051]

According to claim 5, the method for initializing a phase-change optical information recording medium to suffice to reduce undue overlap of initialized portions on the recording medium can be achieved, since two neighboring irradiation tracks during two consecutive rotations of the recording medium in initializing steps, is specified to be equal to, or less than, 0.3 Wr.

[0052]

According to claim 6, excellent initialized characteristics can be achieved of a phase-change optical information recording medium, since the present apparatus for use in initializing the recording medium is provided with various capabilities specified by claims 1 through 5.

[0053]

According to claim 7, excellent recorded signal characteristics can be achieved in a phase-change optical information recording medium, since the present recording medium is initialized by the methods with the various capabilities specified by claims 1 through 5.

[Brief Description of the Drawings]

[FIG. 1]

A schematic diagram illustrating the construction of the initialization head according to one embodiment disclosed herein.

[FIG. 2]

An enlarged view of the major parts of the initialization apparatus additionally including an optical recording medium according to one embodiment disclosed herein.

[FIG. 3]

A schematic cross-sectional view illustrating an optical information recording medium according to one embodiment disclosed herein.

[FIG. 4]

A graphical representation showing 3T land jitters at DOW1 obtained with varying initialization power P and scanning speed V of the initialization head.

[FIG. 5]

A graphical representation showing energy density values obtained with varying initialization power P and scanning speed V.

[FIG. 6]

A graphical representation showing 3T land jitters at DOW 1000 obtained with varying initialization power P and scanning speed V of the initialization head.

[FIG. 7]

A graphical representation showing reflectivity fluctuation, ΔRgh, obtained after initialization with varying initialization power P and scanning speed V.

[FIG. 8]

A graphical representation illustrating the optimum range of scanning velocity versus beam power during initialization steps of the recording medium disclosed herein.

[Description of the Numerals]

1	:	Laser source
2,5	:	Collimator lens
3	:	Splitter
4	:	Objective lens
6	:	Auto-focusing unit
9	:	Optical information recording medium
10	:	Initialization head
11	:	Spindle mechanism

[Name of Document] Drawings

FIGS. 1 through 8.

[Name of Document] Abstract of the Disclosure

[Abstract]

[Object of the Invention]

To provide a method and an apparatus for use in initializing an optical recording medium, which has multi-speed recording capabilities at the velocity of 4.8 m/sec or larger, to attain satisfactory overwrite characteristics up to its largest warranted linear recording velocity.

[Means for Solving the Problems]

A method for initializing a phase-change optical recording medium by irradiating the recording medium with a scanning beam spot emitted from a high power semiconductor laser device, with the recording medium being capable of carrying out optically read/write/erase operations of information data onto the recording medium, which is characterized primarily by an energy density input by the beam spot during one beam scan over an entire medium area being equal to, or less than, 1000 J/m^2. There disclosed herein are additional six claims.

[Selected Drawing] FIG. 2.

FIG. 1

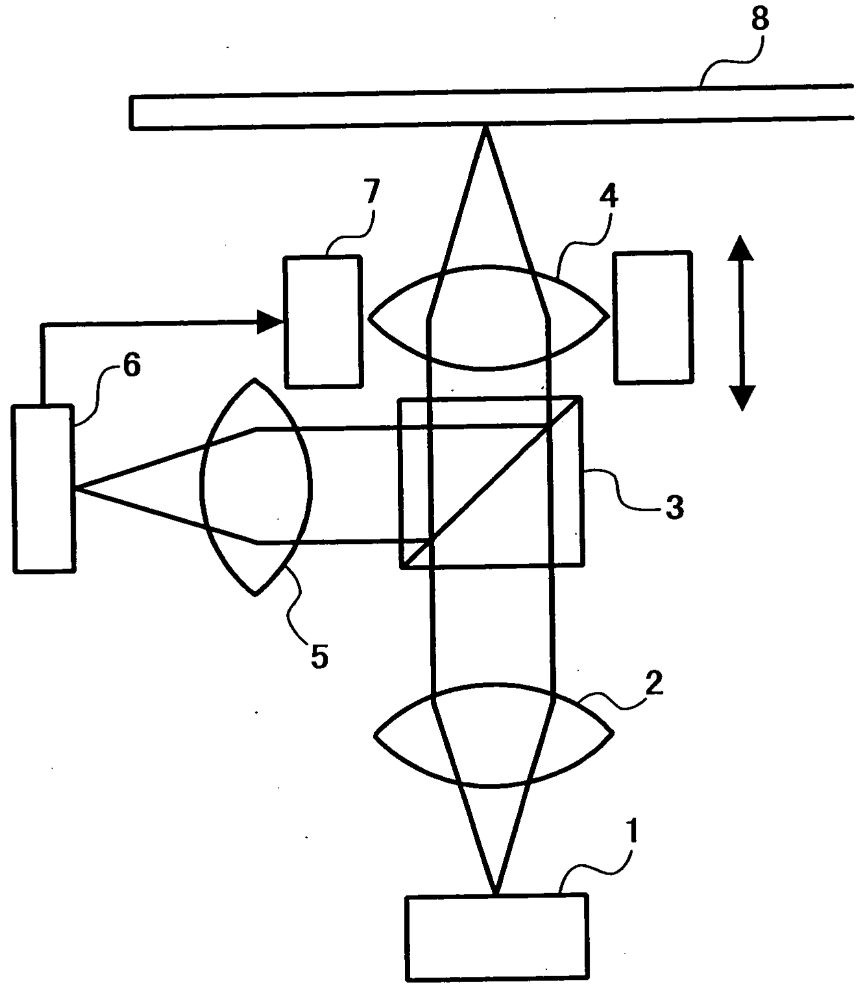


FIG. 2

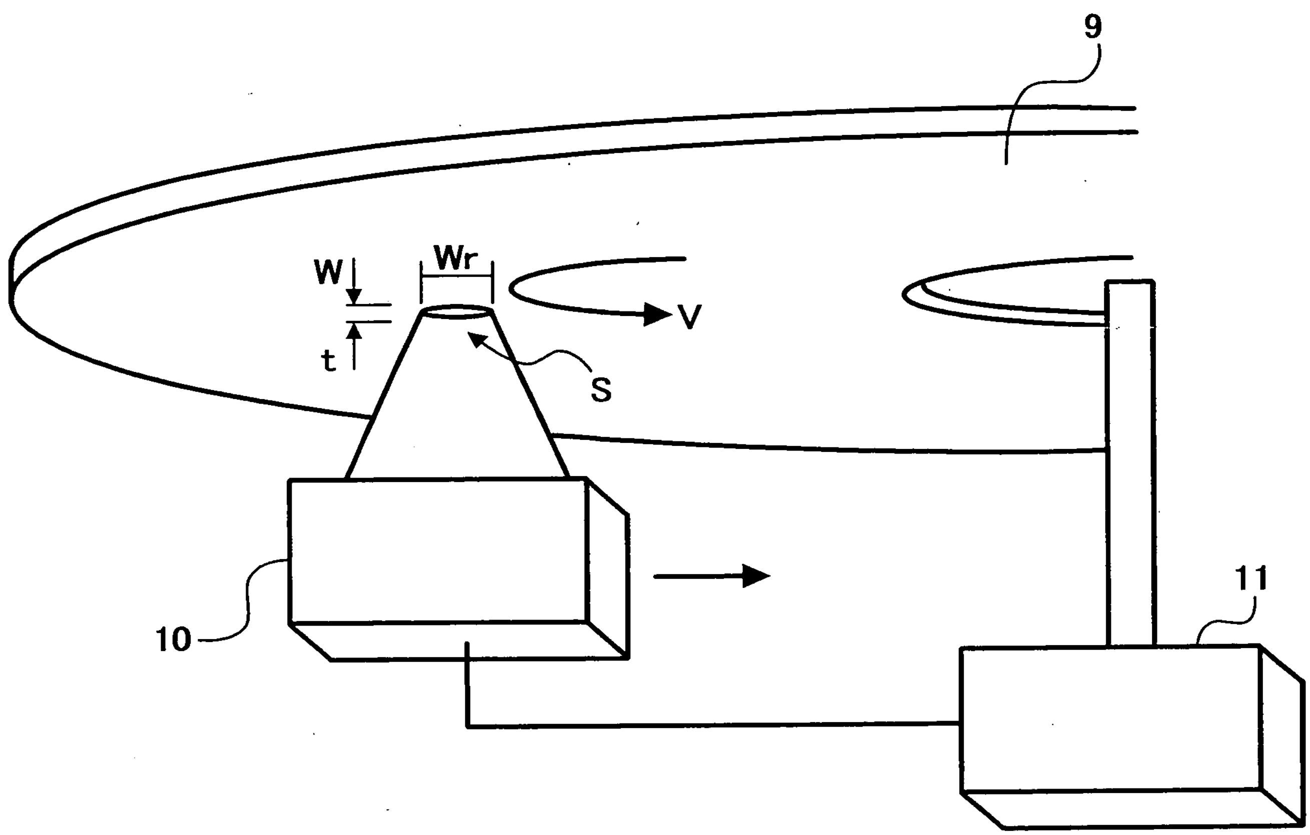
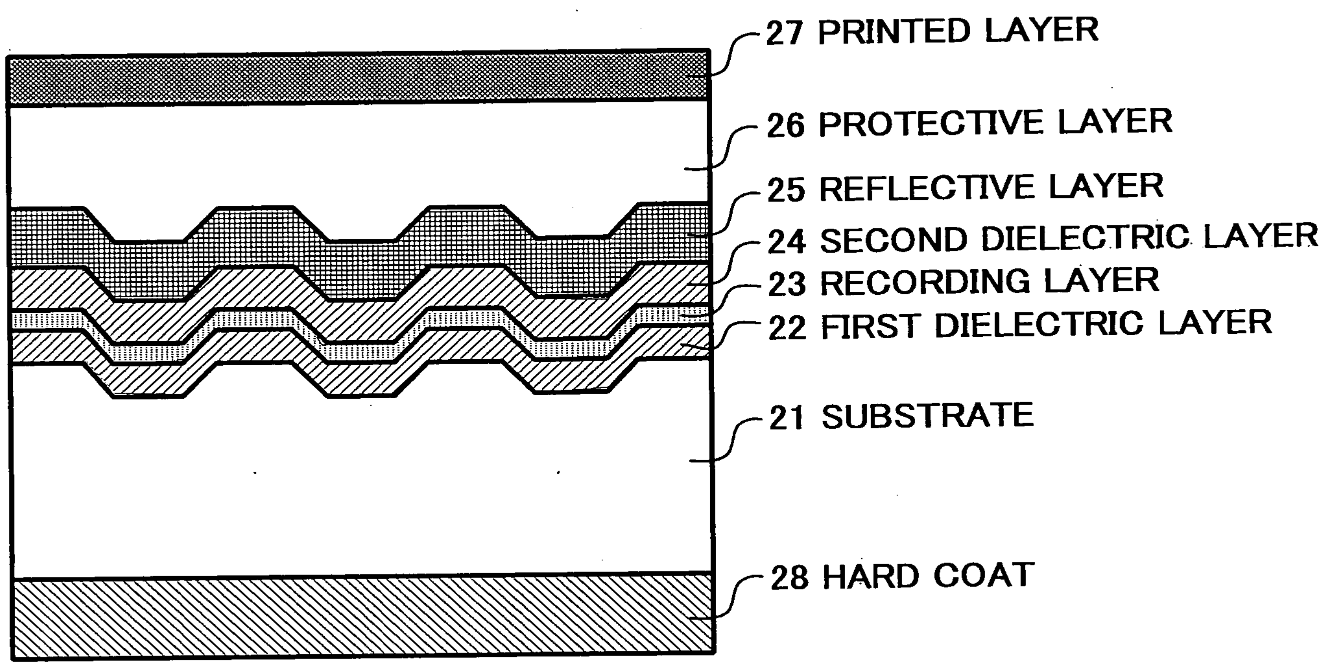


FIG. 3



27 PRINTED LAYER
26 PROTECTIVE LAYER
25 REFLECTIVE LAYER
24 SECOND DIELECTRIC LAYER
23 RECORDING LAYER
22 FIRST DIELECTRIC LAYER
21 SUBSTRATE
28 HARD COAT

FIG. 4

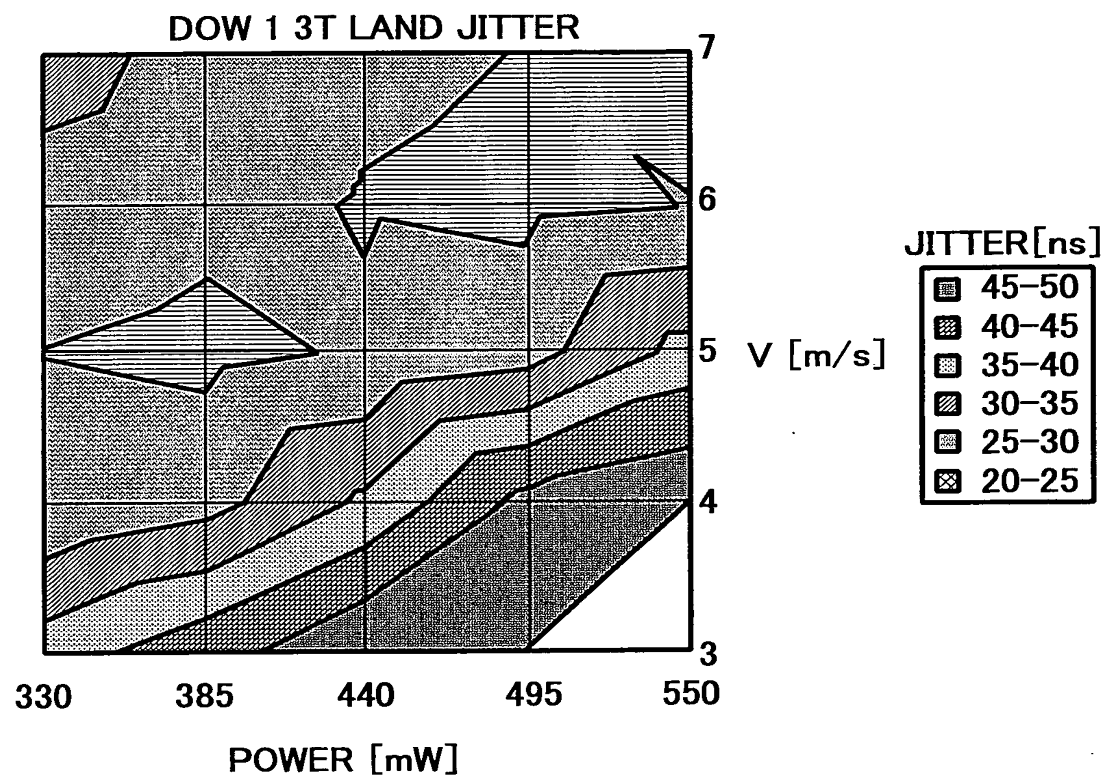

DOW 1 3T LAND JITTER
7
6
5
4
3
V [m/s]
330
385
440
495
550
POWER [mW]
JITTER[ns]
45-50
40-45
35-40
30-35
25-30
20-25

FIG. 5

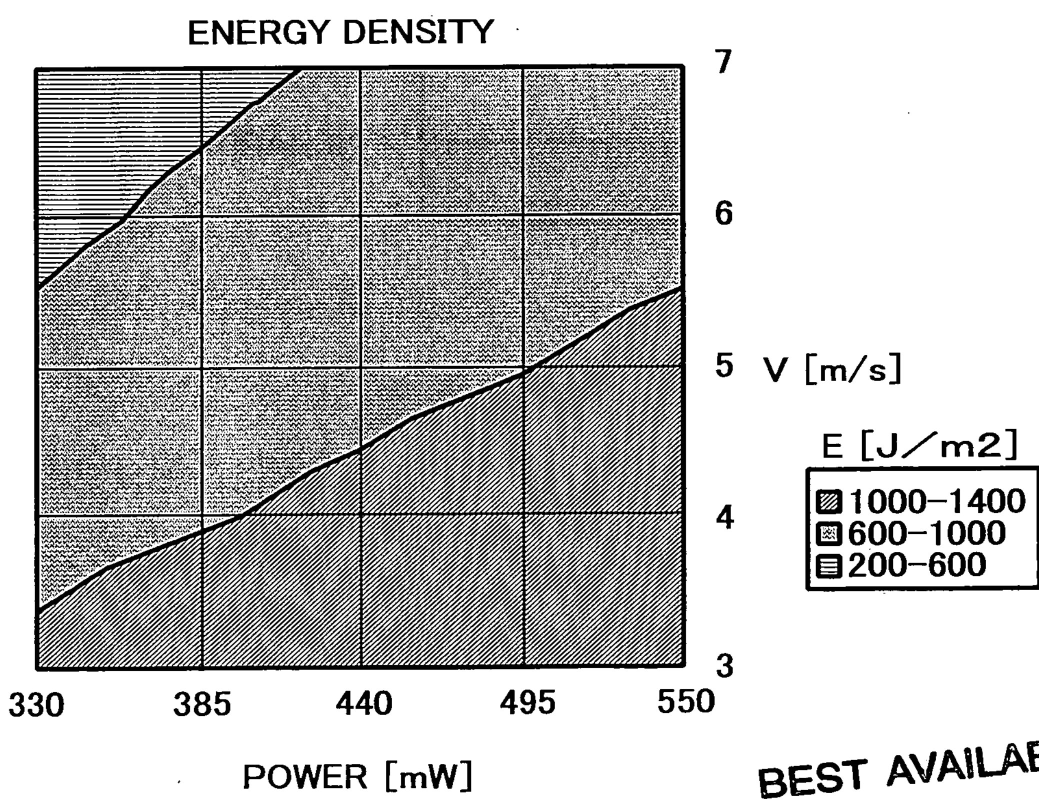

ENERGY DENSITY
7
6
5
4
3
V [m/s]
330
385
440
495
550
POWER [mW]
E [J/m2]
1000-1400
600-1000
200-600

FIG. 6

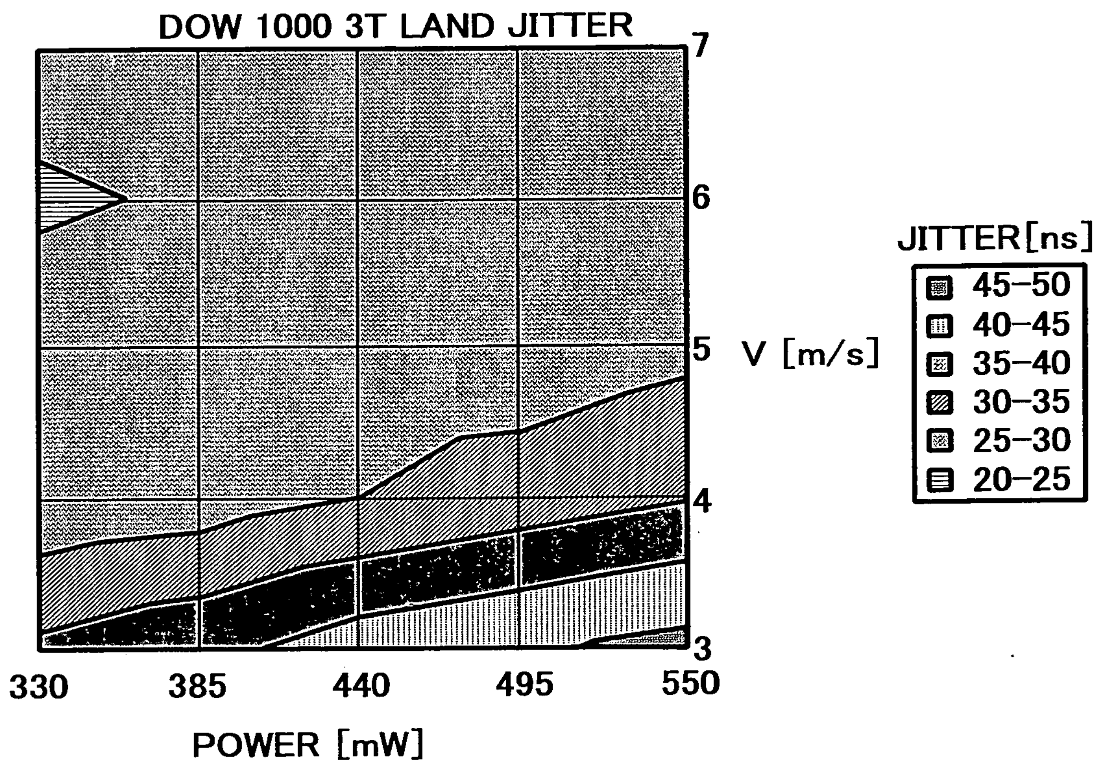

DOW 1000 3T LAND JITTER
7
6
5
4
3
V [m/s]
330
385
440
495
550
POWER [mW]
JITTER[ns]
45-50
40-45
35-40
30-35
25-30
20-25

FIG. 7

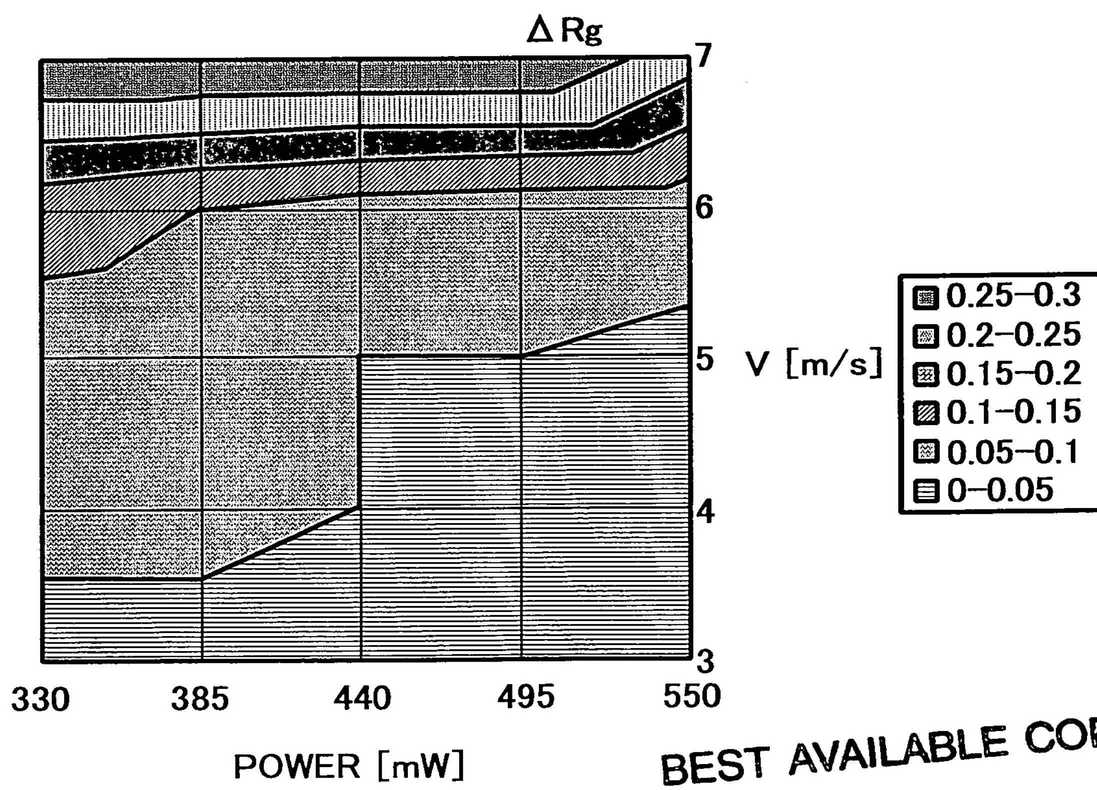

ΔRg
7
6
5
4
3
V [m/s]
330
385
440
495
550
POWER [mW]
0.25-0.3
0.2-0.25
0.15-0.2
0.1-0.15
0.05-0.1
0-0.05

FIG. 8